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Enhanced Critical Care Air Transport Team Training for Mitigation of Task Saturation



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14. ABSTRACT The purpose of this study is to identify if task saturation in Critical Care Air Transport Teams (CCATTs) occurs. CCATTs play an essential role in the delivery of en route care and are specially trained by the U.S. Air Force to care for patients in a variety of platforms. Given the complex patient care environment, the hypothesis is that the occurrence of task saturation would be associated with task and equipment management. The combination of high patient acuity, stress of flight, and need for expertise with a wide assortment of medical equipment raised the concerns that these teams may be at risk for task saturation during the delivery of en route care. This, in turn, may lead to degradation in team performance and patient care. The potential occurrence of task saturation during CCATT missions is of critical importance, as it may lead to degradation in the quality of patient care.				
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1.0 SUMMARY

The primary objective of the study was to identify the occurrence of task saturation among Critical Care Air Transport Teams (CCATTs) during aeromedical evacuation missions. CCATTs are an essential element in the delivery of en route care and are specially trained by the U.S. Air Force to care for patients in a variety of platforms. Given this complex patient care environment, the hypothesis is that the occurrence of task saturation would be associated with task and equipment management. The combination of high patient acuity, stress of flight, and need for expertise with a wide assortment of medical equipment raised the concerns that these teams may be at risk for task saturation during the delivery of en route care.

2.0 INTRODUCTION

The combination of high patient acuity, stress of flight, and need for expertise with a wide assortment of medical equipment raised the concerns that Critical Care Air Transport Teams (CCATTs) may be at risk for task saturation during the delivery of en route care. This, in turn, may lead to degradation in team performance and patient care. Task saturation occurs when required duties exceed the capability to execute them within a given period. Task saturation has been previously studied in the field of aviation and is viewed as a contributing factor to pilot error and loss of aircraft [1]. Despite the similarities between elements of aviation and critical care medicine, the prevalence and impact of task saturation in the care of patients with complex medical conditions have been poorly studied.

3.0 BACKGROUND

Teams are composed of three medical personnel (a physician, a nurse, and a respiratory therapist) who are trained in critical care and care delivery in an austere environment. Each team is responsible for caring for as many as six critically ill patients as well as operating and transporting their equipment, including portable ventilators, invasive monitoring, and infusion pumps. CCATTs are a critical component of the U.S. Air Force (USAF) evacuation paradigm. The current study was conducted to assess the incidence of task saturation in simulated CCATT missions and to determine if there are predictable performance domains.

4.0 METHODS

Current CCATT training includes a 2-week CCATT basic course at the USAF School of Aerospace Medicine followed by an advanced course at the Center for Sustainment of Trauma and Readiness Skills at the University Hospital in Cincinnati, OH. The advanced course consists of a series of didactic lectures focused on the care of the injured and critically ill patient; live patient care on the trauma surgery service, in the surgical and neurosurgical intensive care units, and in the emergency department at the University Hospital in Cincinnati; tabletop discussions; and several simulated CCATT missions. The simulated missions take place in a dedicated facility that replicates many aspects of flight conditions inside a USAF KC-135 airframe during low light conditions, including decking, stanchions, lighting, aircraft noise, and the CCATT equipment allowance standard. Scenarios for simulated missions are developed using patient movement data recorded during previous CCATT patient movement missions.

The University of Cincinnati as well as the USAF granted Institutional Review Board approval for the study and consent was obtained from 48 CCATT trainees. Sixteen CCATTs were videotaped during performance of identical simulated missions over the course of 6 months. The designated mission involved the care of two critically wounded warfighters: one patient with severe burns and an inhalation injury and one patient with bilateral lower extremity traumatic amputations. This scenario was delivered on the Medical Education Technologies, Inc. Human Patient Simulator (CAE Healthcare, Sarasota, FL) in the KC-135 simulator at the University Hospital in Cincinnati, OH. Video, audio, and simulated patient data, including vital signs, were recorded from the simulators as well as multiple camera and audio sources. The simulation scenario contained predefined “crisis events,” defined as an adverse change in a patient’s condition, such as worsening hypotension, hypoxia, self-extubation, or cardiac arrest. These events were time stamped during the recording for later evaluation.

Experts in critical care and medical education reviewed the videotaped missions and evaluated team performance during each crisis event utilizing a rating tool adapted from studies attempting to identify barriers to effective teamwork during cardiac arrests [2,3] as well as a previous study evaluating team performance during an anesthesia crisis [4]. The principal categories of evaluation included teamwork, communication, mutual performance monitoring, maintenance of standards and guidelines, task management, procedural skill, and equipment management. Four performance characteristics were evaluated in each domain to achieve the final score. In addition, each evaluator noted the presence or absence of task saturation during each crisis event as well as the outcome of the intervention (adverse outcome vs. no adverse outcome). A Likert scale was used to assign teams a score from 1 to 10 in each of the performance domains.

Logistic regression analysis was used to determine the association between performance domains and task saturation for these two groups, and a Fisher exact test was used to determine the association between task saturation and adverse clinical outcomes.

5.0 RESULTS

An analysis of 16 simulated missions with 45 crisis events was conducted. The training scenario was designed to have two predetermined crisis events in each mission for 32 crisis events during the study. In 4 of the 16 missions, the team’s care during a planned crisis event led to occurrence of additional crisis events.

Evidence of task saturation was present in 22/45 (49%) of crisis events (Figure 1). There was asymmetry in team susceptibility to task saturation (Figure 2). Twelve teams demonstrated evidence of at least one episode of task saturation. Four teams showed no evidence of task saturation. Of teams with task saturation during crisis events, three had a single task saturation crisis event, while the remaining had more than one (Figure 2).

Team performance was evaluated in the areas of teamwork, communication, mutual performance monitoring, maintenance of standards and guidelines, task management, procedural skill, and equipment management. Given the complex patient care environment, the hypothesis was that the occurrence of task saturation would be associated with task and equipment management. When data analysis was performed in each domain, the occurrence of task saturation was associated with poor performance in the domains of teamwork, communication, and mutual performance monitoring, but not maintenance of standards and guidelines, task management, procedural skill, and equipment expertise (Figure 3).

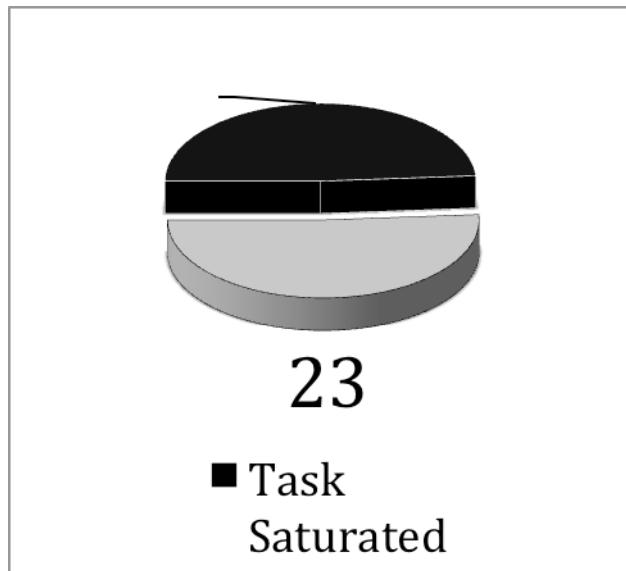
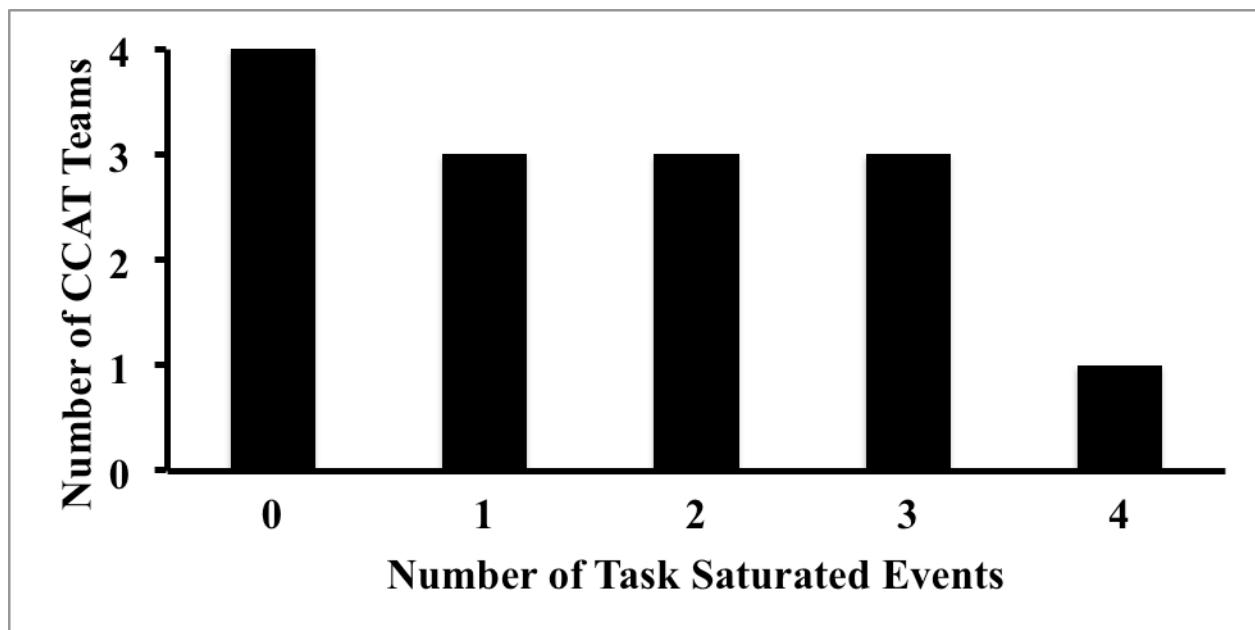


Figure 1. Incidence of Task Saturation among 16 CCATTs during a Simulated Mission. Approximately half of the 45 crisis events showed evidence of task saturation.



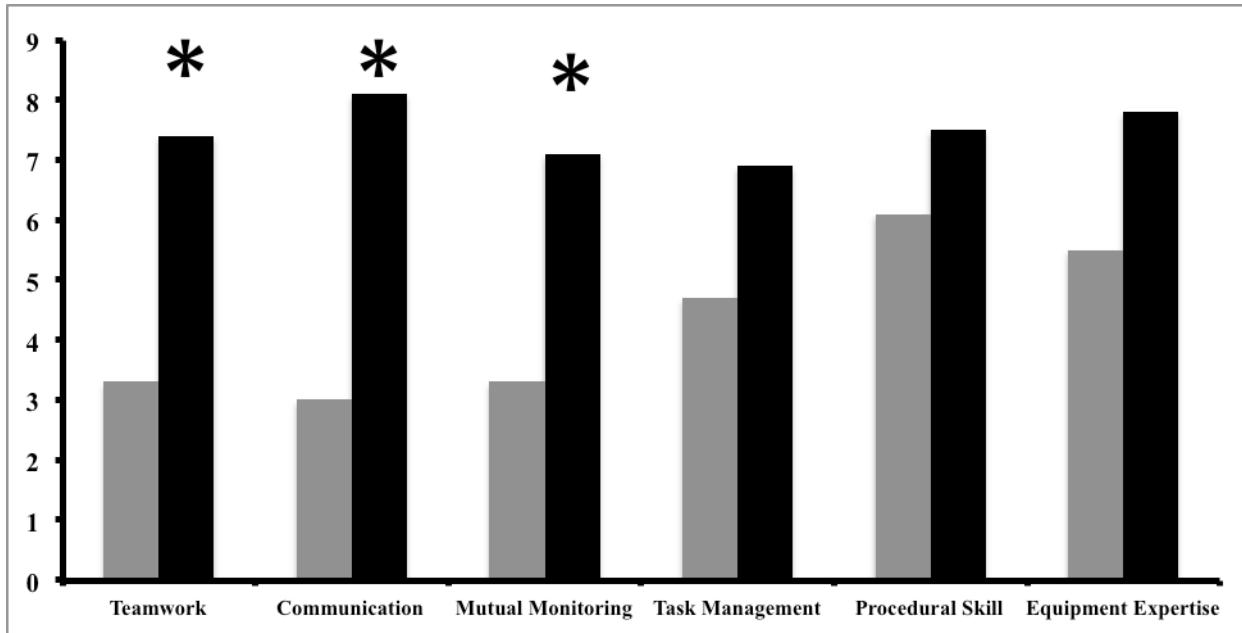


Figure 3. Results of Team Performance in 6 Domains of Performance.

Vertical bars represent global rating (grey = task saturated, black = not task saturated). *Teamwork, communication, and mutual performance monitoring were statistically different between groups that were task saturated vs. those that were not task saturated. No significant differences were found in the domains of task management, procedural skill, and equipment expertise. * $p<0.05$

Additional analysis indicated that performance in each domain was differentially associated with task saturation. Odds ratios (ORs) favoring task saturation were greatest for communication (OR=2.08), followed by teamwork (OR=1.96) and mutual performance monitoring (OR=1.9; Figure 4).

The potential effect of task saturation on patient outcomes during each crisis event was analyzed. Adverse outcomes, as defined by worsening physiology, were more common when teams were task saturated as compared to non-task-saturated teams (91% vs. 23%; relative risk 4.1; 95% confidence interval 1.84-8.77, $p<0.0001$, Figure 5). A logistic regression analysis was used to determine the impact of a 1-point increase in each of the scores across the domains of performance. When these subcategories were analyzed, those that had the greatest impact on the likelihood of improving team performance were knowledge sharing (OR 2.66, $p=0.06$) and reevaluation (OR 2.39, $p=0.05$).

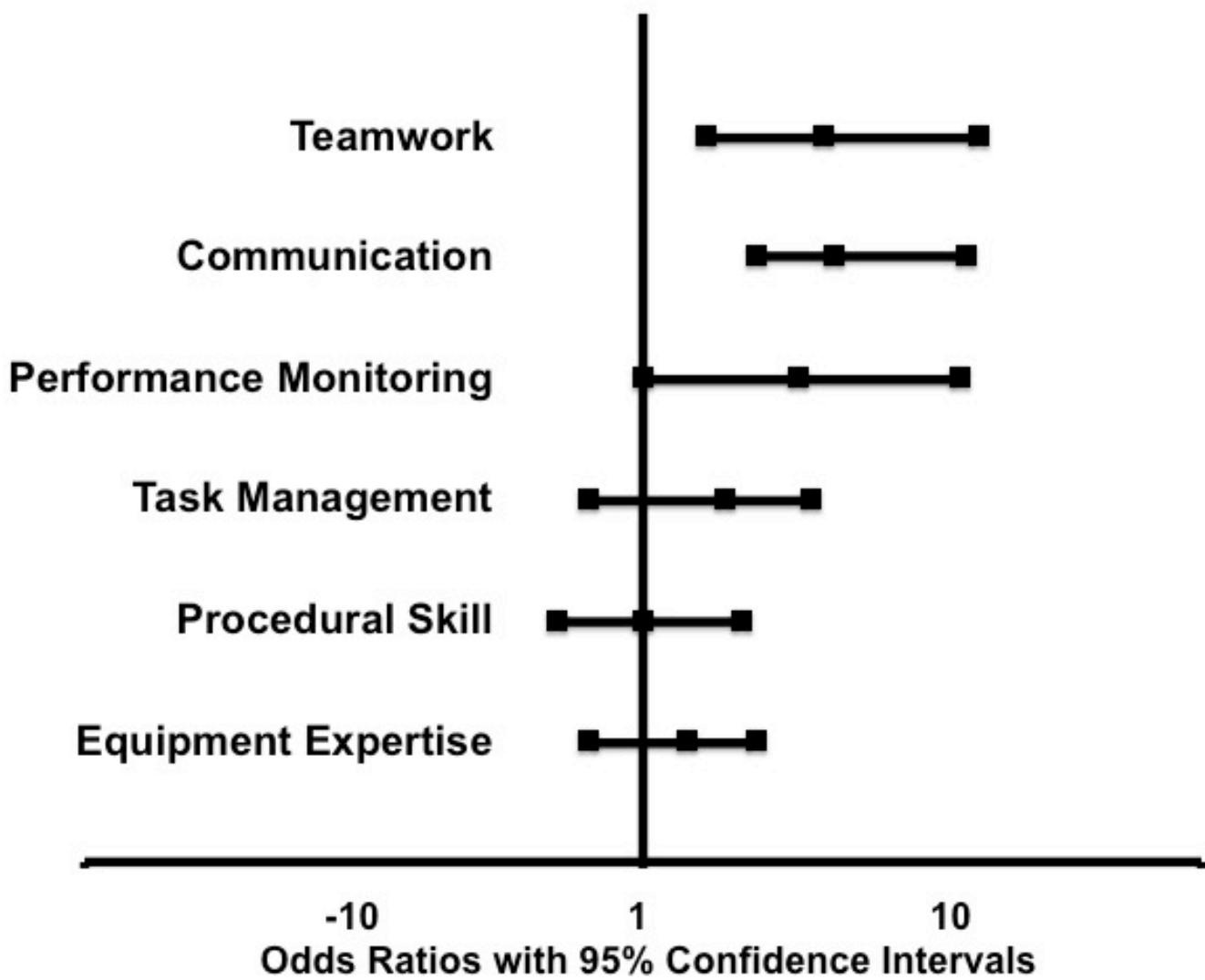


Figure 4. Odds Ratios Displayed as a Forest Plot. Vertical line represents an OR of 1.0, demonstrating no association between the domain of performance and the presence of task saturation. Teamwork and communication strongly correlate with task saturation, and performance monitoring remained significant. Task management, procedural skill, and equipment expertise all failed to show significance.

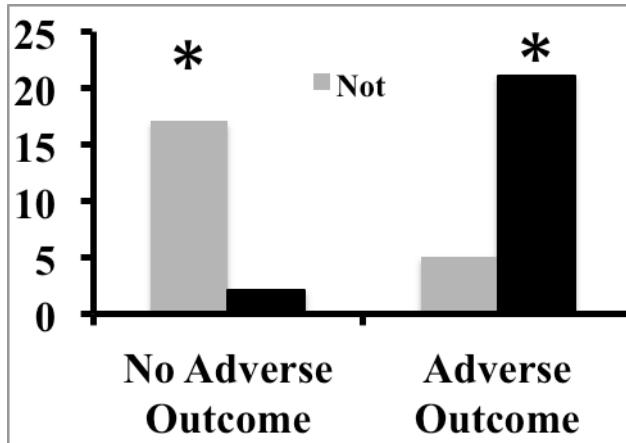


Figure 5. Adverse Outcomes Were Significantly Associated with Task Saturation When Compared to Non-Task-Saturated Events

6.0 DISCUSSION

In the present study, we examined the occurrence of task saturation during simulated CCATT patient care missions. Our data indicated that task saturation was a common occurrence in this setting; was related to poor teamwork, communication, and mutual performance monitoring; and led to adverse simulated patient care outcomes.

Care of critically ill and wounded casualties in combat zones has evolved dramatically in the past 30 years. Along with increasing use of damage control procedures in far-forward settings, increased emphasis has been placed on stabilization and rapid evacuation of casualties [5]. Military medical experience, especially surrounding the Battle of Mogadishu, where nearly 50% of casualties required evacuation [6], led to the development and establishment of CCATTs.

In current practice, CCATTs are a rapidly deployable resource and a primary component of the USAF's aeromedical evacuation system [7]. The goal of a CCATT is to turn almost any airframe into a flying intensive care unit within minutes. The team consists of three highly specialized members (physician, critical care nurse, and respiratory therapist) trained to handle the complex, critical nature of patients in hemodynamic flux who require continual stabilization and advanced care and may even require life-saving invasive interventions during transport. The availability of CCATT patient transport has changed the approach to combat casualty care, allowing ongoing delivery of care en route to the next facility and enabling the rapid transport of patients out of theater to increasing levels of specialized care. During the 6-year period between 2001 and 2006, a reported 3400 CCATT missions were performed in support of Operations Iraqi Freedom and Enduring Freedom [8]. In the 12-month period between 2005-6, 134 patients were transported between Balad Air Base, Iraq, and Landstuhl Regional Medical Center, Germany [9]. The mean injury severity score of the trauma patients transported during this study period was 20, and 57% were mechanically ventilated [9]. This indicates a high degree of complex critical care and the potential need for life-saving interventions en route and has been reported by others [10,11].

Task saturation, also known as task overload, occurs when the number or complexity of task requirements exceeds the ability to execute them at a high level. Although task saturation may occur during any complex work set, it is especially important in the medical setting, as it may lead to degradation of the effectiveness of patient care delivery. Task saturation occurrence has been suggested in such disparate work sets as triage of trauma patients [2], cardiac arrest resuscitation [2], evaluation of surgical floor patients [12], and operating room crises [4].

Task saturation may increase with increasing complexity of the care environment. The CCATT patient care environment is challenging at baseline and becomes dramatically more complex during crisis events in flight. Although the incidence of critical events during CCATT missions is unknown, some inferences may be made from existing data. Lehman and colleagues examined the occurrence of adverse events during rotary wing transport in a combat environment over a 7-month period. Results concluded that more than 50% of patients required mechanical ventilation and 20% required vasoactive medications during flight. The rate of crisis events was high, with in-flight clinical deterioration occurring in 30% of patients and equipment failure in 17% of flights [13]. Another recent study examined critical events during civilian air transport, revealing that critical events occur at least once for every 12.6 hours of transport time [14]. Taken together, these data suggest that critical events likely occur with regular frequency during CCATT missions, increasing the challenges of caring for patients in this environment and potentially leading to task saturation. This study's data confirm that the resuscitation and clinical management of critically ill patients require not only sound medical judgment but also competency in nontechnical skills such as leadership, problem solving, communication skills, and resource management [15]. As emergencies with acutely ill patients can arise in any CCATT mission, effective crisis management is crucial. These nontechnical skills have been described as "crisis resource management" [16]. The concept is similar to crew resource management and has been studied using validated tools in the medical community. This study reinforces that the domains of performance associated with crisis resource management are essential to mitigate task saturation in simulated CCATT missions and may have important implications for current CCATT advanced training.

The CCATT advanced course is currently focused on the care of critically ill and injured patients as well as expertise in the CCATT allowance standard. Studies of team performance in operating rooms as well as this study demonstrate that professional experience alone does not automatically lead to the acquisition of nontechnical skills [17]. In review of the study results, suboptimal teamwork, communication, and mutual performance monitoring placed a team at risk for task saturation. This is consistent with past research showing that poor communication, failure to establish leadership, strained interpersonal relations, and lack of preparation increase the risk to patients undergoing an operation [1,17]. Communication failure has been demonstrated in 30% of team exchanges in the operating room. Poor communication was shown to be the primary root cause of patient harm in 70% of sentinel events [18]. Teamwork and performance monitoring have been demonstrated to influence outcomes in other medical settings [19,20], and their influence in this study confirms the importance of CCATT training prior to deployment.

There are three recognized coping mechanisms that people employ when faced with task saturation [21]. The first is "shutting down," where someone either quits the task or takes frequent breaks. This is the most harmless of the coping mechanisms, mainly because it is evident that the person is no longer executing his/her mission; the mental collapse is not being

masked. Another coping mechanism is “compartmentalization,” where the person acts busy but accomplishes little. People employing this mechanism may make lists, shuffle things around, and create the illusion of doing work, thus masking that they are task saturated. This coping mechanism is also characterized by linear thinking, where tasks are completed one at a time without regard to priority. Task saturation is hard to identify in these people because they look busy. The final coping mechanism is “channelizing,” also known as “target fixation.” It is estimated that 80% of task-saturated people cope by channelizing. This is when a person becomes intensely focused on one thing at the expense of everything else. Other tasks are neglected and ignored and new tasks accumulate. Study results demonstrated evidence of these coping mechanisms during the simulated missions. Compartmentalization manifested itself as teams moving equipment around or walking around the simulator without making any forward progress. In addition, monitors also witnessed linear thinking, with low-priority tasks being completed before high-priority ones. Channelizing occurred as well, with teams at times congregating around one patient to intubate him while the other patient suffered from worsening hypotension.

The harmful effects of task saturation have wide implications within the field of medicine. Data suggest that degradation in teamwork and communication during crisis events may lead to task saturation, with associated negative impact on patient care. We suspect that these findings extend beyond the CCATT environment and are applicable to many high complexity care environments. Future efforts to mitigate task saturation should focus on improving teamwork and communication during crisis events.

7.0 CONCLUSION

Task saturation is observed in simulated CCATT missions. Nontechnical skills correlate with task saturation. Task saturation is associated with worsening physiologic derangements in simulated patients.

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LIST OF ABBREVIATIONS AND ACRONYMS

CCATT Critical Care Air Transport Team

OR odds ratio

USAF United States Air Force